

# Open-Source Development with Intel AI Retail Suite Project

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# Agenda

- Introduction
- CV-based AI/ML Retail Use Cases
- AI Retail Suite Project
- Workshop
- Project GitHub + Compliances
- Project Contributions
- Conclusion
- Take-Home Hackathon – Deadline Monday 27<sup>th</sup> 11:59 pm - Midnight

# Team/Speakers



**Neethu Elizabeth Simon**

Senior Software Engineer  
Intel Corporation



intel.



**Antonio Martinez**

Senior Software Engineer  
Intel Corporation



**Brian McGinn**

Senior Software Engineer  
Intel Corporation



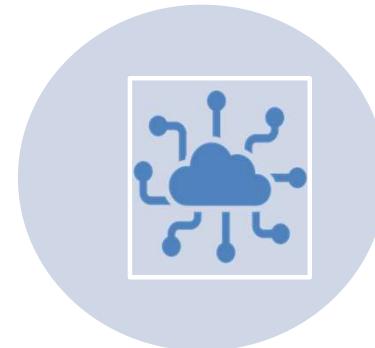
**Elizabeth Lee**

Senior Software Engineer  
Intel Corporation



# Introduction

- New and innovative markets
- Increasing industry support
- Strong drivers:
  - Cheaper and faster processors and wireless networks
  - AI/ML Advancements



INTERNET OF THINGS IS A GROWING WEB  
OF NUMEROUS DEVICES THAT ARE  
INTERCONNECTED AND INTERACTING

NUMBER OF "THINGS" GETTING  
INSTALLED AND CONNECTED IS  
GROWING

Global IoT Market worth – \$153.2B by 2029, growing at 18.8%

<https://www.marketsandmarkets.com/Market-Reports/internet-of-things-market-573.html>

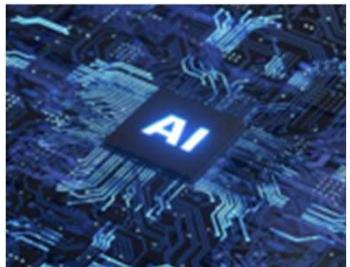
# CV-based AI/ML Retail Use Cases

- Camera is the ultimate “Thing”
- CV + AI = “Eye of IOT”
- Smart Retail Use Cases



# AI Challenges

# What are Some of the AI Challenges Today?



## GPU Availability

AI is Heterogenous and alternatives exist

## Vendor Lock-in

Avoid vendor lock-in with open-source standards-based software

## Cost

Need better price and performance across hardware and software portfolio

## Secure AI

Set the trust boundary appropriate to your workloads

# Intel Retail AI Suites - Automated Self-Checkout Project Performance Benchmarking Retail Use Cases

# Our Objective

## Make it Easy to Work with AI on Intel®

### Hardware

- Most cost optimized hardware
- Recommend hardware for scale
- Accurate ROI calculations

### Software

- Software for bootstrapping
- Customize AI pipelines per use case
- Benchmarking custom workloads

## Build an Engaged Partner Community



<https://github.com/intel-retail>



**Discord**



<https://discord.gg/2SpNRF4SCn>



# Automated Self-Checkout Reference Implementation

Helping Build Vision Enabled Systems

Automated Self-Checkout Retail Reference Implementation



- Source Code
- Microservices
- Documentation
- Learning Videos
- Benchmark Script
- Hardware Recommandation
- Pre-Trained Models

Tools & Libraries

**OpenVINO™**

Intel® OpenVINO Model Server to run inferencing across many frameworks with optimised performance

**docker**

Operating System Support

**ubuntu**

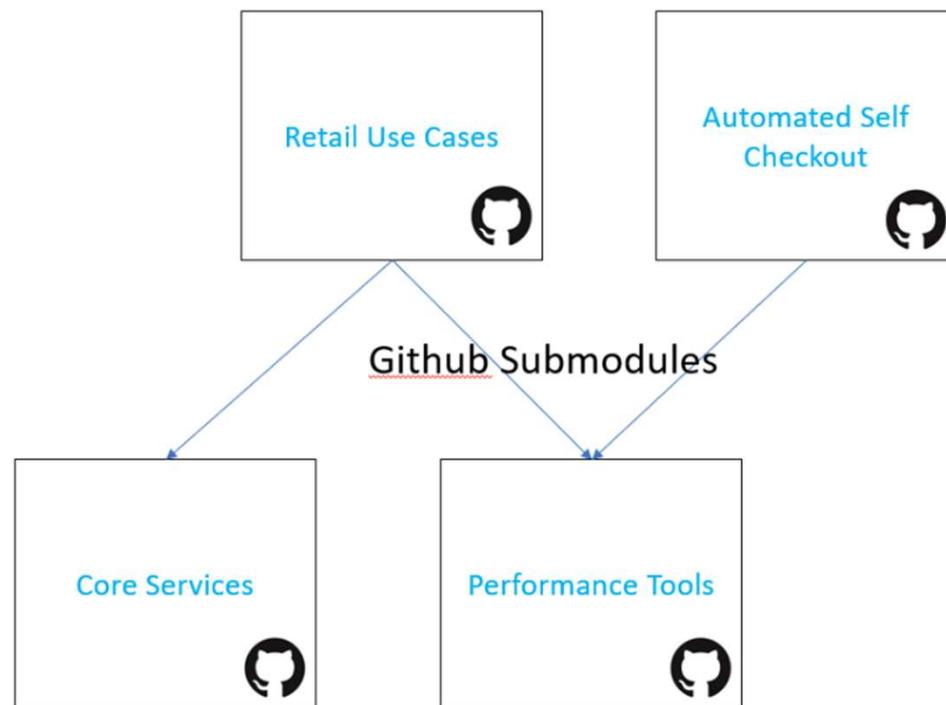
Support for Platforms Based on Intel® Architecture



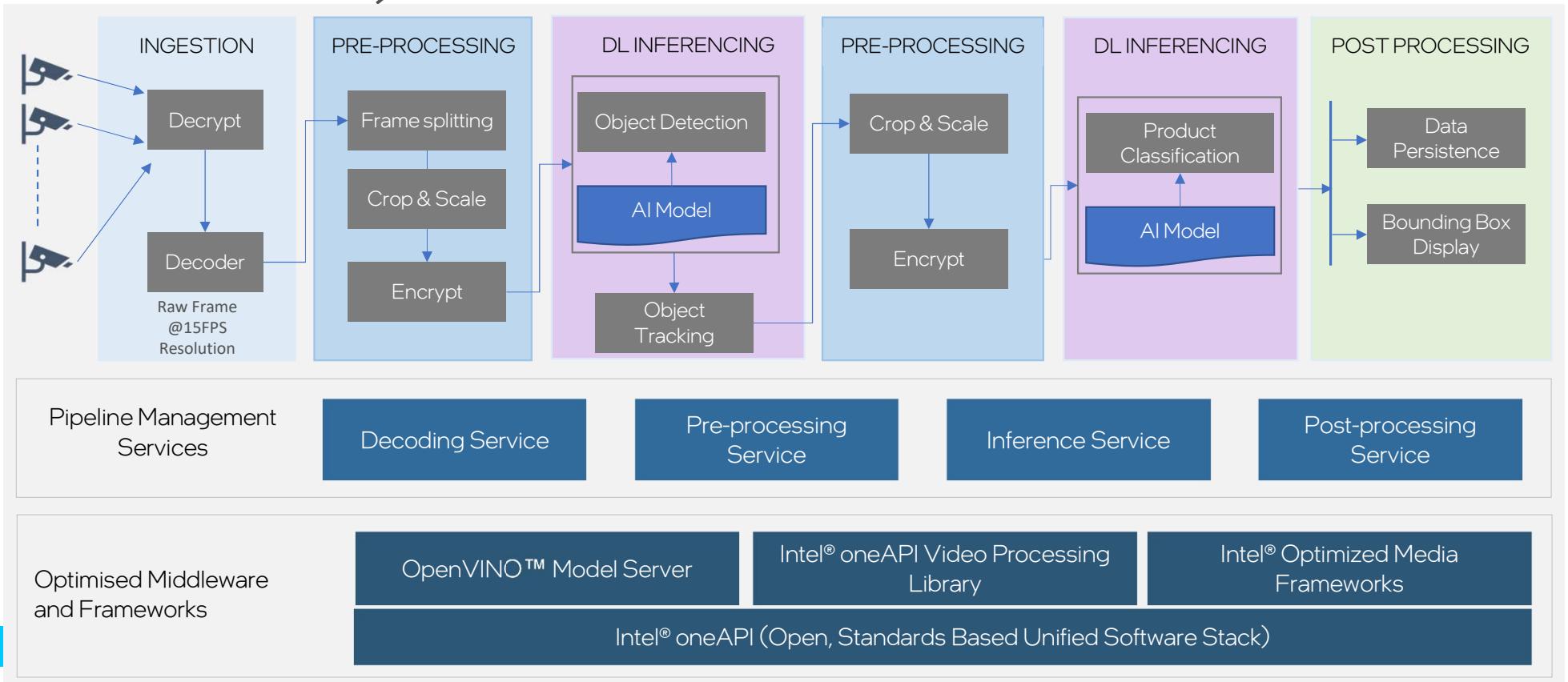
# Automated Self-Checkout Reference Implementation



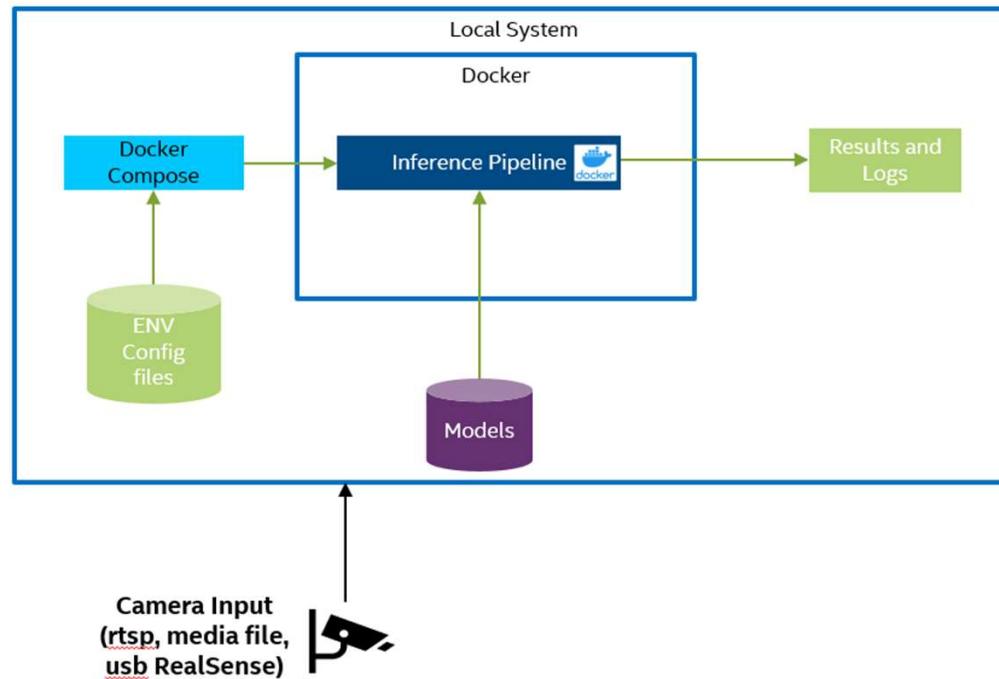
<https://github.com/intel-retail/>



# Vision Inference Pipeline (Object detection + Classification)



# Architecture



## Legend

<span style="background-color: #00529e; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	Docker Containers
<span style="background-color: #00aaff; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	Docker yml
<span style="background-color: #9acd32; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	Text File
<span style="background-color: #800080; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	AI Model
<span style="color: green;">→</span>	File System Operation
<span style="color: red;">→</span>	gRPC Request
<span style="color: black;">→</span>	USB/Network Request

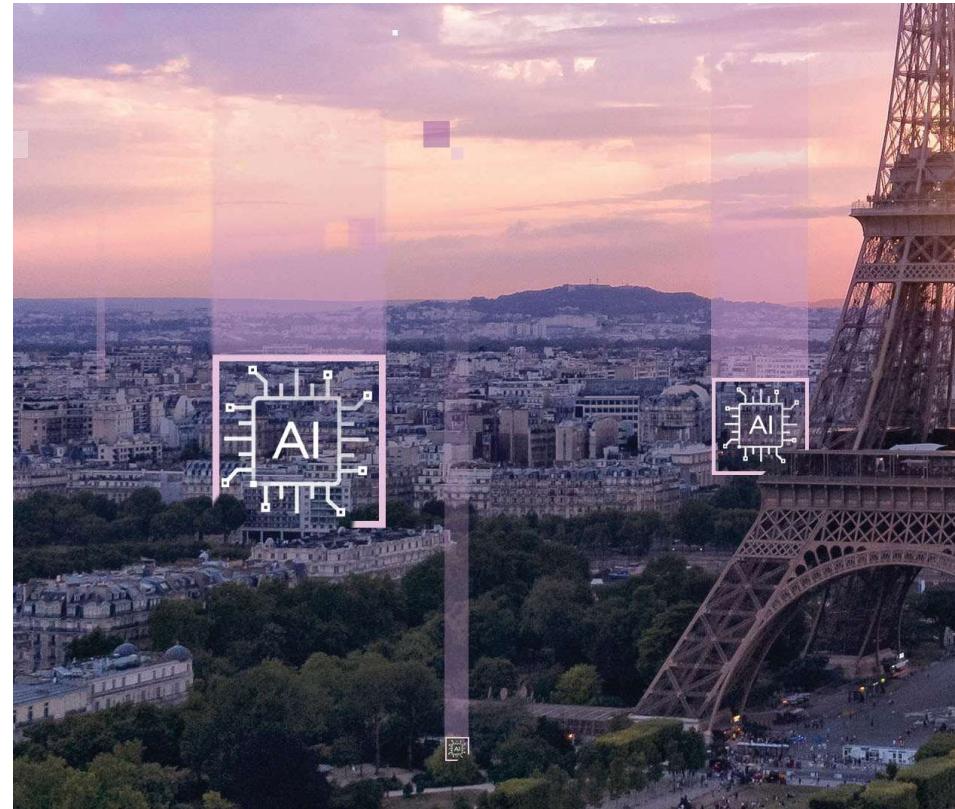
# Workshop

# Pre-requisites

- OS – Preferably Ubuntu 22.0
  - Can work on lower versions, however latest features are not tested there
  - If using Windows, then can use Ubuntu on Windows via WSL  
<https://learn.microsoft.com/en-us/windows/wsl/install>
- Hardware – Intel CPUs (minimum core 8th gen, can have Intel GPUs too)
- Software –
  - Docker (Tested on version >= 23.0.0)
  - Docker Compose v2
  - Git
  - Make - install with apt install make
  - OpenVINO installation –  
[https://github.com/openvinotoolkit/openvino\\_notebooks?tab=readme-ov-file#-installation-guide](https://github.com/openvinotoolkit/openvino_notebooks?tab=readme-ov-file#-installation-guide)
- Optional – Camera (in-built or separate) for live feed

# Definitions

- AI involves teaching computers to process data in a way that mimics the human brain
- Computer Vision is a field of AI that focuses on enabling computers to interpret visual data
- AI and CV are important in our lives for several reasons:
  - Automation
  - Medicine
  - Safety
  - Customer experience

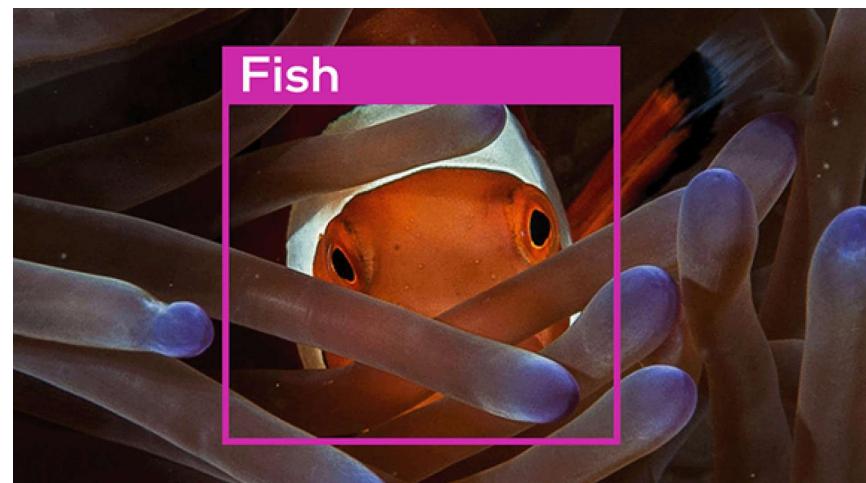
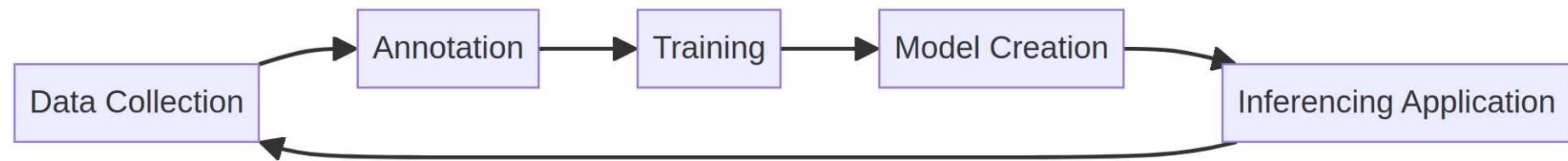


# Computer Vision Use cases

- Robotics
- Retail
- Surveillance and Security
- Medical Imaging

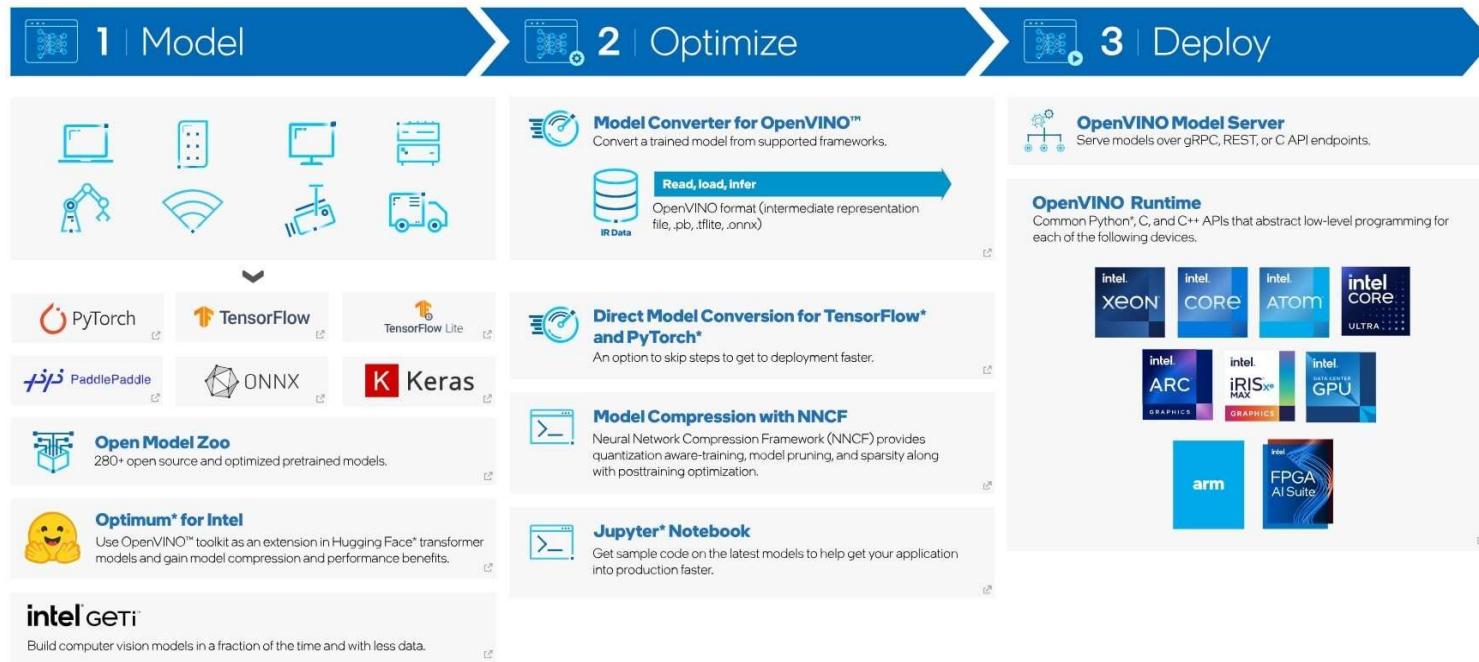


# Pre-train AI Models



# Intel® Distribution of OpenVINO™ Toolkit

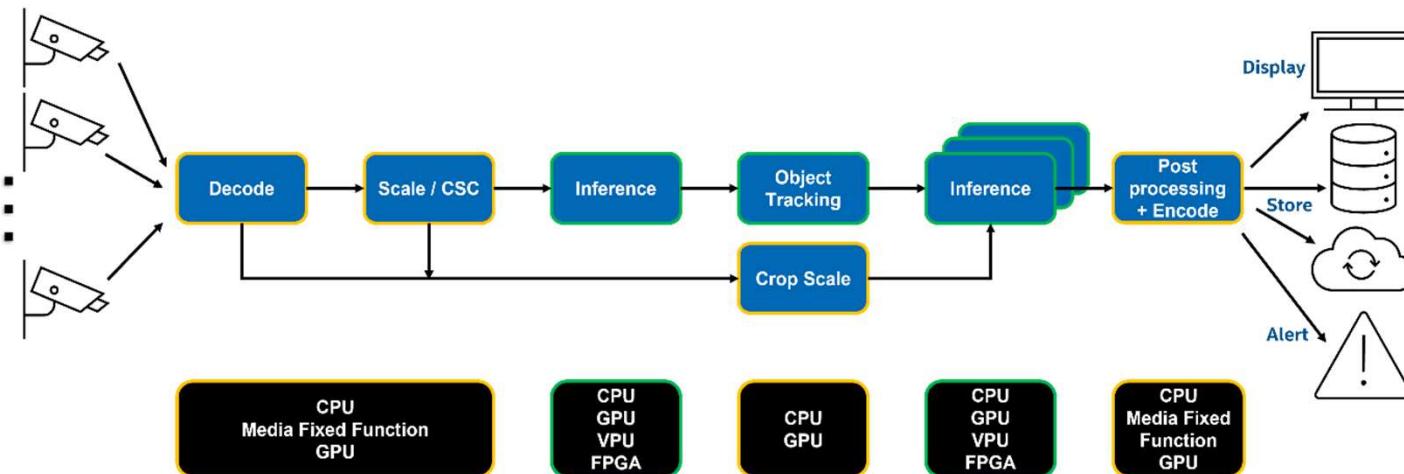
- Opensource toolkit that accelerates AI inference.
- Used for AI development and integration of deep learning in domains like computer vision, LLM and GenAI.



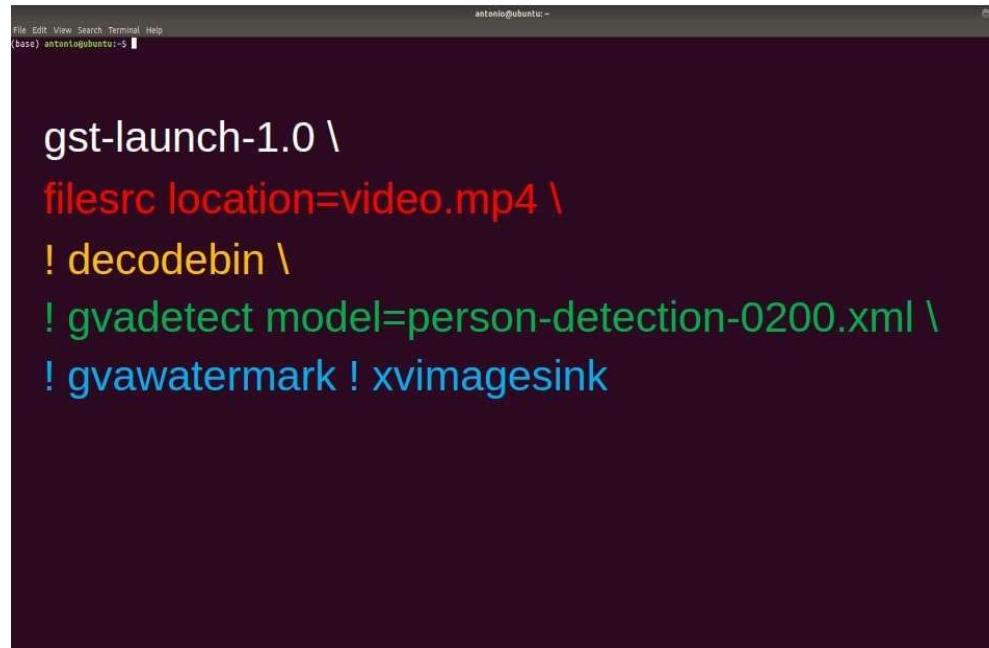
intel.

# Intel® DLStreamer

- Streaming media analytics framework, based on Gstreamer + OpenVINO inference engine.
- Enables developers to create deep learning pipelines across Intel architecture.



# Intel® DLStreamer Demo

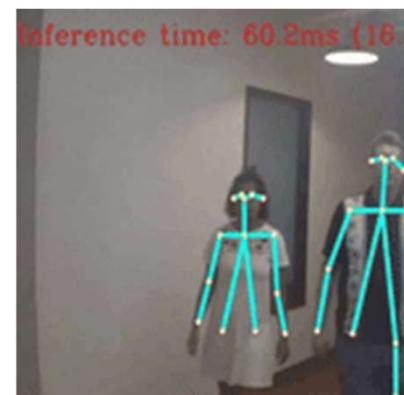


A terminal window titled "antonio@ubuntu:~" with the command:

```
gst-launch-1.0 \
  filesrc location=video.mp4 \
  ! decodebin \
  ! gvadetect model=person-detection-0200.xml \
  ! gvawatermark ! xvimagesink
```



# OpenVINO Jupyter Notebooks



# GenAI

- Text to Video/Image generator
- Large Language Models (LLM)
- Visual-Language Models (VLM)
- Sound generators

Darth Vader surfing on waves



A beautiful pink unicorn



# Performance Benchmarking

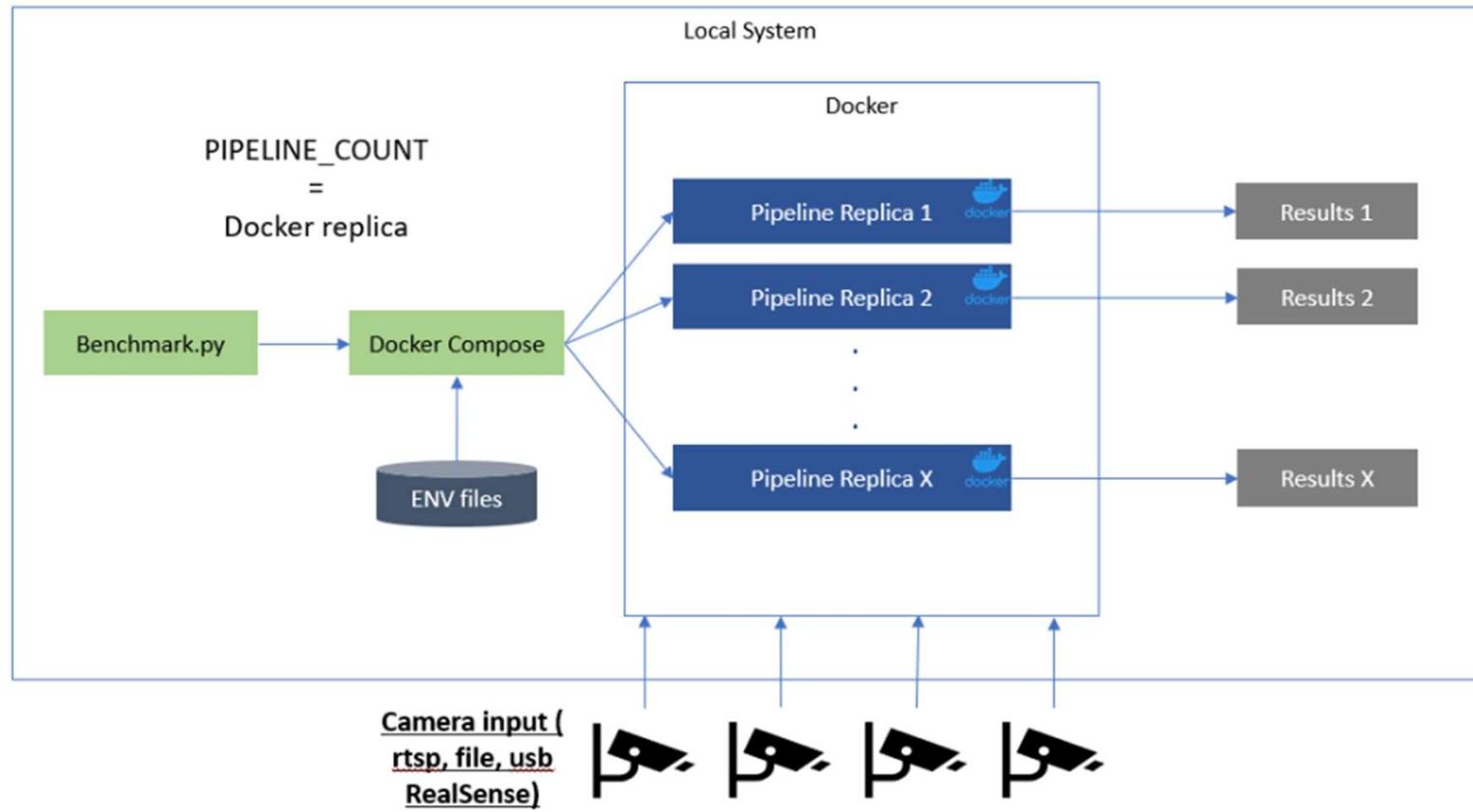
# Performance Benchmarking

- You can benchmark pipelines with a collection of scripts to get the pipeline performance metrics such as video processing in frame-per-second (FPS), memory usage, power consumption, and so on.

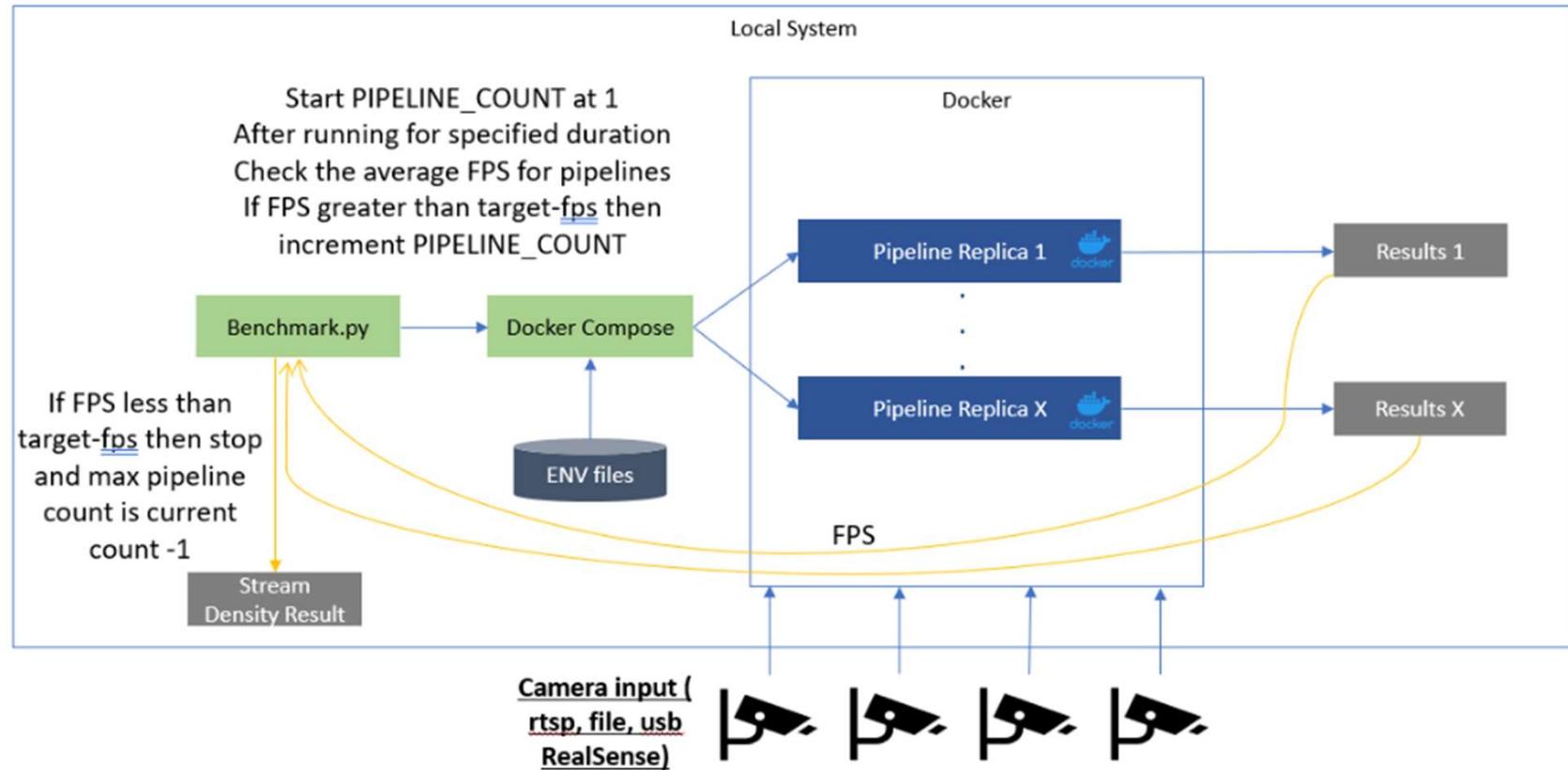
```
Stream density TARGET_FPS set for 14.9 and INIT_DURATION set for 30
Starting single container stream density benchmarking
Starting pipeline: 1
waiting for pipelines to settle
FPS for pipeline0: 30.9545
Total FPS throughput: 30.9545
Total FPS per stream: 30.9545
Starting pipeline: 3
waiting for pipelines to settle
FPS for pipeline0: 14.668
FPS for pipeline1: 14.0375
FPS for pipeline2: 14.0805
Total FPS throughput: 42.786
Total FPS per stream: 14.262
Starting pipeline: 2
waiting for pipelines to settle
FPS for pipeline0: 25.384
FPS for pipeline1: 36.1835
Total FPS throughput: 61.5675
Total FPS per stream: 30.7838
Max stream density achieved for target FPS 14.9 is 2
Finished stream density benchmarking

,Metric,10objs
0,Total Text count,NA
1,Total Barcode count,NA
2,Camera_0 FPS,15.786
3,Camera_0 Last log update,08/24/2023 00:04:858186
4,CPU Utilization %,11.3
5,Memory Utilization %,28.593
6,Disk Read MB/s,0.001
7,Disk Write MB/s,0.002
8,S0 Memory Bandwidth Usage MB/s,3487.143
9,S0 Power Draw W,14.227
10,GPU_0 VDBOX0 Utilization %,5.736
11,GPU_0 GPU Utilization %,38.864
```

# Performance Architecture



# Stream Density



Bring Your Own AI Pipeline  
and  
Integrate with Intel Retail AI Suite for  
Performance Benchmarking



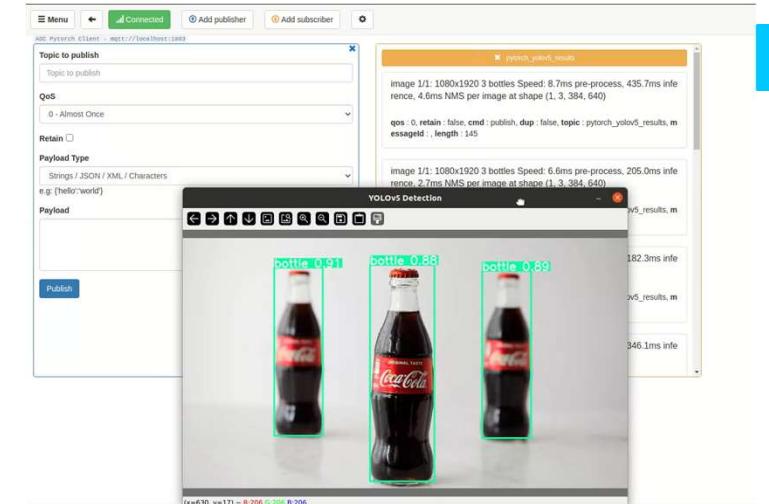
# Integration Steps

- Build your own AI/ML pipeline
- *git clone https://github.com/intel-retail/retail-use-cases.git*
- Add Your AI code to intel-retail/retail-use-cases repo –  
<https://github.com/intel-retail/retail-use-cases/tree/main/use-cases/demos>



# Integration Steps

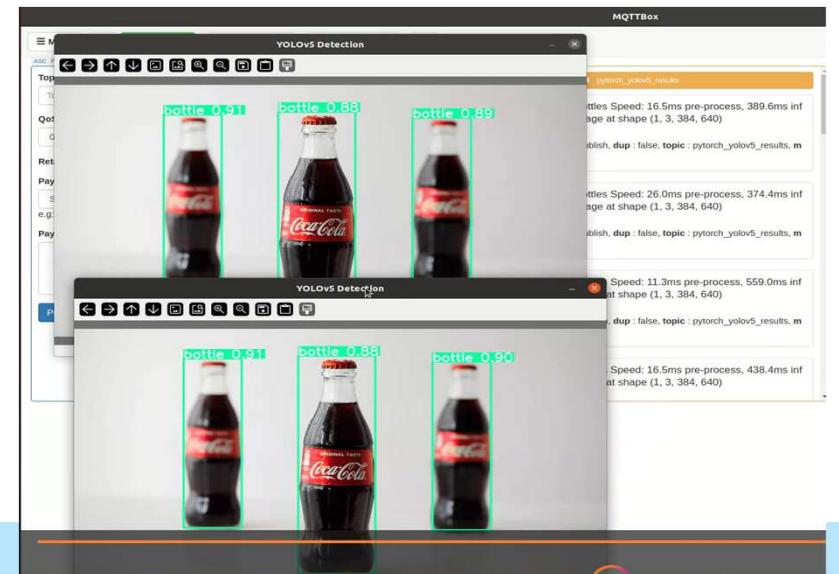
- Build pipeline – make build\_pytorch
- Run 1 pipeline – make run\_pytorch\_object\_detection
- Run 2 pipeline –  
PIPELINE\_COUNT=2 make run\_pytorch\_object\_detection



- Start MQTT client to view results – use MQTTBox, MQTTX or cmd
- Result and Performance logs under results folder



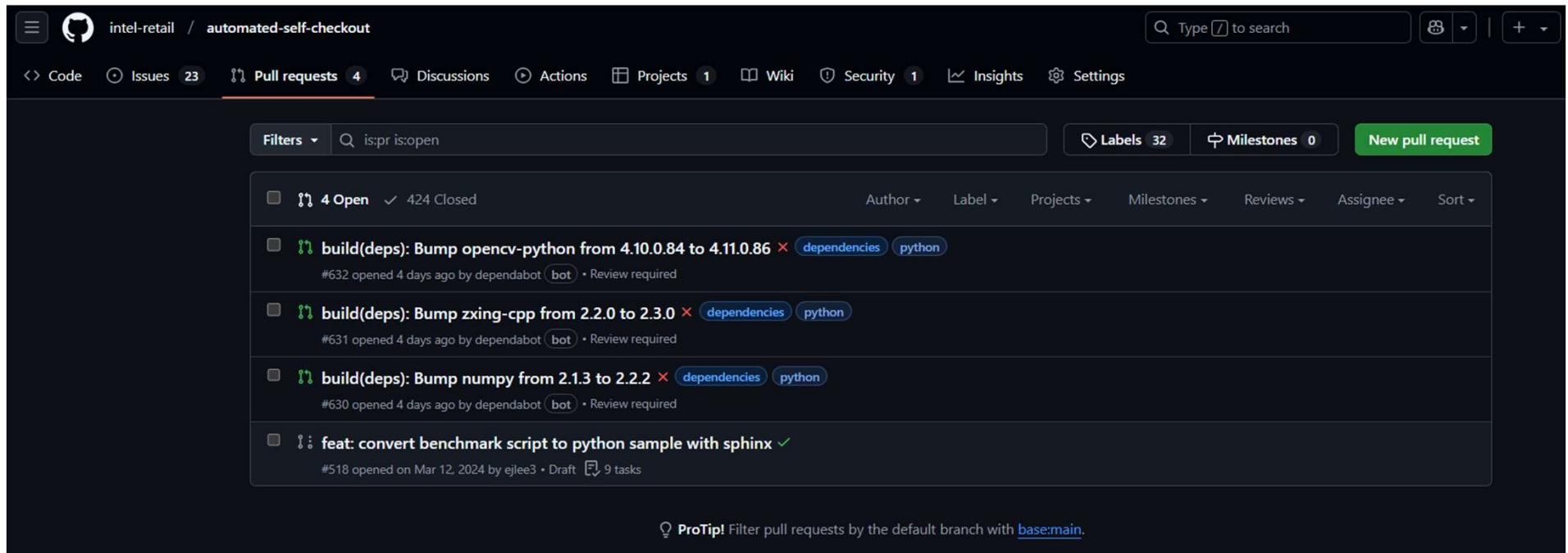
intel.



# GitHub: GitHub Actions, Security Review Tools, and the PR Code Review Process - Brian

# Pull Request

<https://github.com/intel-retail/automated-self-checkout/pulls>



The screenshot shows the GitHub interface for the repository `intel-retail/automated-self-checkout`. The navigation bar includes links for Code, Issues (23), Pull requests (4), Discussions, Actions, Projects (1), Wiki, Security (1), Insights, and Settings. A search bar at the top right allows users to search for pull requests. Below the search bar are buttons for Labels (32), Milestones (0), and New pull request.

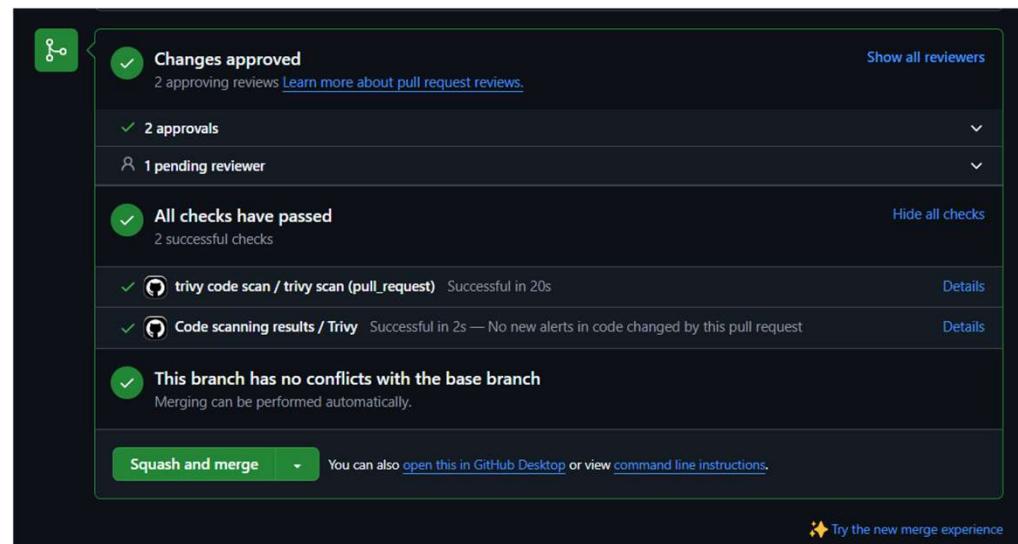
The main content area displays a list of pull requests:

- #632**: build(deps): Bump opencv-python from 4.10.0.84 to 4.11.0.86 - dependencies python - Review required
- #631**: build(deps): Bump zxing-cpp from 2.2.0 to 2.3.0 - dependencies python - Review required
- #630**: build(deps): Bump numpy from 2.1.3 to 2.2.2 - dependencies python - Review required
- #518**: feat: convert benchmark script to python sample with sphinx - Draft 9 tasks

A ProTip! message at the bottom suggests filtering pull requests by the default branch with `base:main`.

# Pull Request Validation

- Requires 1 or more review approvals
- Github Actions automatically validate all pull requests
- Validation must pass before merging



# Github Actions

<https://github.com/intel-retail/core-services/actions>

The screenshot shows the GitHub Actions page for the `intel-retail/core-services` repository. The left sidebar lists various actions and management features. The main area displays a table of workflow runs, showing 195 runs across different events, statuses, branches, and actors. Most runs are successful (green checkmark), while some are failed (red X). The table includes columns for Event, Status, Branch, Actor, and a more details button.

Event	Status	Branch	Actor	More
Merge pull request #20 from intel-retail/dependabot/go_modules/profil...	main	1 hour ago	24s	...
Merge pull request #20 from intel-retail/dependabot/go_modules/profil...	main	1 hour ago	59s	...
build(deps): Bump golang.org/x/net from 0.26.0 to 0.33.0 in /profile-launcher	dependabot/go_modules/profil...	2 hours ago	20s	...
build(deps): Bump golang.org/x/net from 0.26.0 to 0.33.0 in /profile-launcher	dependabot/go_modules/profil...	2 hours ago	1m 13s	...
build(deps): Bump golang.org/x/net from 0.26.0 to 0.33.0 in /profile-launcher	dependabot/go_modules/profil...	2 hours ago	29s	...
build(deps): Bump golang.org/x/net from 0.26.0 to 0.33.0 in /profile-launcher	dependabot/go_modules/profil...	2 hours ago	50s	...
build(deps): Bump golang.org/x/net in /profile-launcher	dependabot/go_modules/profil...	2 hours ago	31s	...
go_modules in for golang.org/x/net - Update #952709976	main	2 hours ago	58s	...



Overview of the Project Issue/Feature List, how to make Requirement/Feature Requests, and Picking Up Issues - Brian

# Open Issues

<https://github.com/intel-retail/automated-self-checkout/issues>

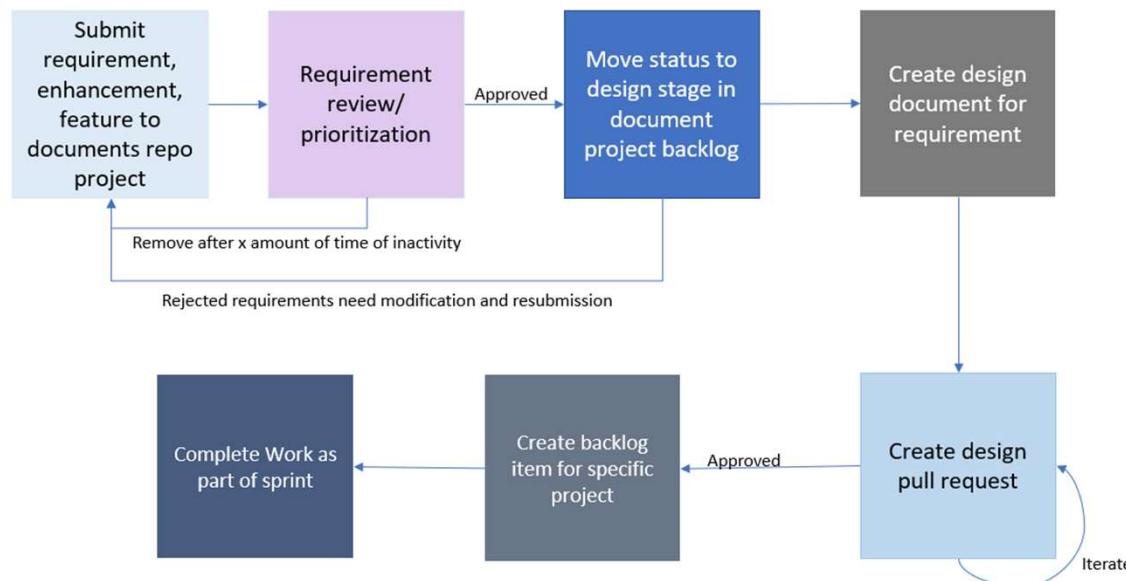
The screenshot shows the GitHub Issues page for the repository `intel-retail/automated-self-checkout`. The search bar at the top contains the query `is:issue state:open`. Below the search bar, there are filters for `Author`, `Labels`, `Projects`, `Milestones`, `Assignees`, `Types`, and a dropdown for `Newest`. The main list displays the following open issues:

- Legacy Issue Template Deprecated** (`Beginner`, `bug`)  
#634 · brian-intel opened 17 hours ago
- RTSP stream** (`Intermediate`, `bug`)  
#633 · brian-intel opened 18 hours ago
- Spike: SceneScape access to project**  
#627 · antoniomtz opened on Nov 20, 2024
- Standardize the Environment settings between Docker Compose Files** (3.2, `Beginner`, `enhancement`)  
#623 · brian-intel opened on Oct 7, 2024
- ASC: Ability to run-demo on GPU via RTSP** (`Advanced`)  
#614 · sanchal22 opened on Aug 22, 2024
- Spike: ASC Fuzzing Testing** (`Beginner`)  
#606 · mechris1 opened on Aug 5, 2024
- Provide data visualization support for all these data (eg grafana dashboard)** (`Advanced`)  
#547 · NeethuES-intel opened on Mar 26, 2024
- Consolidate data from all the nodes** (`Advanced`)  
#546 · NeethuES-intel opened on Mar 26, 2024
- Update the performance tools to collect metrics from all the nodes** (`Advanced`)  
#545 · NeethuES-intel opened on Mar 26, 2024

# Submitting a requirement

<https://github.com/intel-retail/documentation>

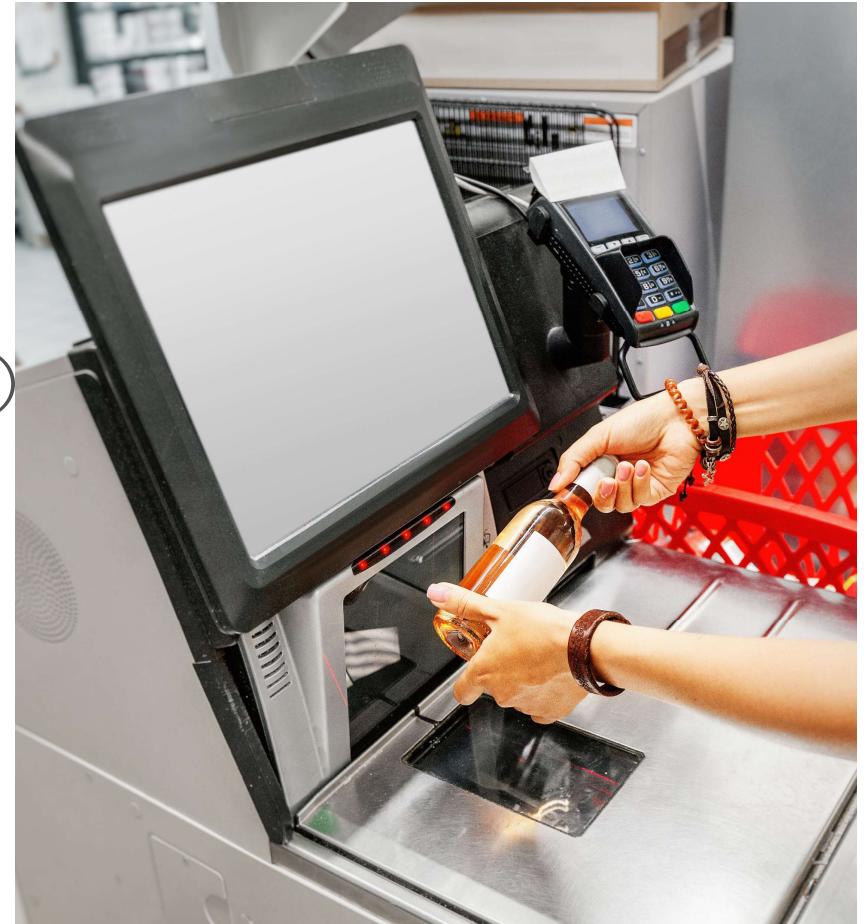
## Requirements Review Process Flow





## Future Features

- Add multi-camera item tracking to the loss prevention pipeline
- Add additional configurations for the latest Intel hardware (ex. NPU support)
- Continual learning and retraining to complement our pre-trained models



# Conclusion

# Community Call to Action

- Fork the repository
- Look into contributing
- File issues and requirements
- Join our Discord for communication



<https://github.com/intel-retail>



**Discord**



<https://discord.gg/2SpNRF4SCn>

# Take-Home Coding Hackathon - Rules

- Team participation - can have between 2 to 3 members in your team.
- Take-Home Hackathon starts now
- Submission Deadline – Monday 27<sup>th</sup>, Midnight 11:59 pm
- Prizes to be won – 1<sup>st</sup> ,2<sup>nd</sup> ,3<sup>rd</sup> and Rookie Award (Undergrads)



<https://github.com/intel-retail>



<https://discord.gg/2SpNRF4SCn>

# Take-Home Coding Hackathon – What/How

- Select any repo under intel-retail
- Select any issues to work on from the list under Issues tab or create your own issue as New issue to work on
- Existing issues labeled as – Beginner, Intermediate, Advanced
- Make sure to assign the issue to your group
- Fork the repository to your account
- Work on the issue
- Create PR to upstream your changes
- Submit as many PRs as you like within the Deadline
- For any questions, either comment on the issues or reach out in Discord

# Take-Home Coding Hackathon – Judging Rules

- The judges will evaluate your PRs on GitHub.
- Expect some back-and-forth communication to happen to enable the upstreaming of your PR.
- When your PR is merged, the judges will score the PR based on the quality of your contributions.
- They will use the "Judging Criteria" to score the contributions.
- The judge's scores are final.
- Results will be announced by Monday, February 3<sup>rd</sup>

# Take-Home Coding Hackathon – Judging Criteria

- Feel free to contribute to any of the categories below.
- Based on the category of your submission, the Judges will score your contributions based on the complexity, completeness, and code/documentation quality.
- The judges' scores are final.
- The maximum score per category is listed below:

Criteria	Max Score
Bug Fix	40
Documentation	20
Feature Implementation (Business Value(20)/ Architecture(20)/ Innovation(20)/ Code Quality(20)/ User Experience(20))	100
Unit Tests	30
Integration Tests	30
CI CD/Compliance/Automation	30

# Thank You Questions?

Join & Build with Us



**Neethu Elizabeth Simon**  
Senior Software Engineer  
Intel Corporation



**Antonio Martinez**  
Senior Software Engineer  
Intel Corporation



**Brian McGinn**  
Senior Software Engineer  
Intel Corporation

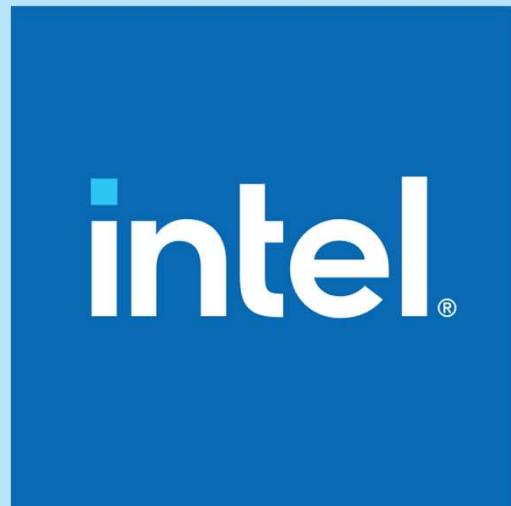


<https://github.com/intel-retail>



<https://discord.gg/2SpNRF4SCn>





# OpenVINO Notebooks

Activities SimpleScreenRecorder

openvino toolkit/openvino... x pose-estimat... (2) - Jupyter x openvino toolkit/openvino\_notebooks x + Oct 29 18:54

github.com/openvino toolkit/openvino\_notebooks

openvino toolkit / openvino\_notebooks

Type to search

Code Issues 9 Pull requests 6 Discussions Actions Projects 1 Wiki Security Insights

latest 18 Branches Tags Go to file Add file Code

eaidova update transformers version in whisper notebooks (#2487) bdd8a5f · 6 hours ago 2,048 Commits

.binder specify runtime for binder (#1782) 8 months ago

.ci add tokenizers and genai version print in validation and fix ... 5 days ago

.docker Bump werkzeug from 3.0.3 to 3.0.6 in .docker (#2477) 2 days ago

.github Change whisper-subtitles-generation.ipynb to genai pipelin... 2 weeks ago

licensing 220-yolov5-accuracy-check-and-quantization demo (#592) 2 years ago

notebooks update transformers version in whisper notebooks (#2487) 6 hours ago

selector Python312 (#2424) last month

supplementary\_materials Chatbot timeout increasing (#2428) 28 days ago

utils add helper for export models via optimum cli (#2471) (#2474) 5 days ago

.gitignore Remove digits from directories and notebooks names (#1827) 7 months ago

CONTRIBUTING.md Python312 (#2424) last month

Dockerfile Add Gradio helpers - part 8 (#2337) last month

Jenkinsfile Update Jenkinsfile last year

LICENSE Add notebooks and updated README from develop branch... 3 years ago

Makefile add makefile for CI (#348) 3 years ago

About

Jupyter notebook tutorials for OpenVINO™

machine-learning computer-vision  
deep-learning inference openvino

Readme Apache-2.0 license  
Security policy

Activity

Custom properties

2.4k stars  
53 watching  
807 forks

Report repository

Releases

No releases published

Contributors 118

104 contributors

# Automated Self-Checkout

The Intel® Automated Self-Checkout Reference Package provides critical components required to build and deploy a self-checkout use case using Intel® hardware, software, and other open-source components.

[intel-retail.github.io/documentation/](https://intel-retail.github.io/documentation/)

computer-vision    python3    openvino-toolkit  
openvino-model-server

Readme  
Apache-2.0 license  
Code of conduct  
Security policy  
Activity  
Custom properties  
27 stars  
4 watching  
21 forks

Report repository

Releases 7

3.1.0 (Latest)

File / Commit	Description	Date
brian-intel Feat: v3.1.0 merge to main (#621)	feat: Kubernetes support to Automated Self Checkout (#581)	4 months ago
.deploy	[StepSecurity] ci: Harden GitHub Actions (#594)	4 months ago
.github	feat: Pipeline Server versions of automated self checkout (#...)	3 months ago
download_models	fix: revert as casing in dockerfile to resolve codeql vuln (#616)	2 months ago
helm	replaced gif	5 months ago
notebooks	feat: Update for multi camera simulators	2 months ago
performance-tools @ 197209f	Feat: v3.1.0 merge to main (#621)	3 weeks ago
src	feat: Add CONTRIBUTING.md (#200)	last year
telegraf	Rebase 1.5.0. with main (#150)	last year
.gitignore	Rebase 1.5.0. with main (#150)	last year
.gitmodules	feat: Add README.md (#150)	5 months ago
CONTRIBUTING.md	Rebase 1.5.0. with main (#150)	5 months ago
Dockerfile.docs	feat: Kubernetes support to Automated Self Checkout (#581)	4 months ago
LICENSE	feat: Add Dockerfile (#150)	5 months ago
Makefile	feat: v3.1.0 merge to main (#621)	3 weeks ago
README.md	doc: fix documentation link and update performance tools h...	5 months ago

```
intel@intel: ~/projects/automated-self-checkout
intel@intel:~/projects/automated-self-checkout$ make PIPELINE_SCRIPT=yolov5s_effnetb0.sh DEVICE_ENV=res/all-cpu.env BATCH_SIZE=1 RESULTS_DIR=cpu PIPELINE_COUNT=2 benchmark
I

Every 5.0s: docker ps -a
intel@intel: ~
intel: Tue Oct 29 14:21:03 2024
CONTAINER ID   IMAGE      COMMAND   CREATED     STATUS      PORTS      NAMES
```

```
intel@intel: ~/projects/automated-self-checkout
intel@intel:~/projects/automated-self-checkout$ make PIPELINE_SCRIPT=yolov5s_effnetb0.sh DEVICE_ENV=res/all-cpu.env BATCH_SIZE=1 RESULTS_DIR=density TARGET_FPS=14.95 benchmark-stream-density
```

```
intel@intel: ~
intel@intel: ~
Every 5.0s: docker ps -a
intel: Tue Oct 29 14:11:11 2024
CONTAINER ID   IMAGE      COMMAND   CREATED     STATUS      PORTS      NAMES
```